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Reply to: 3420 Date: March 16, 1993

Subject: A Biological Evaluation "A Preliminary Validation of a Douglas-fir Beetle Hazard Rating System, Mountain Home Ranger District, Boise National Forest."

To: Chief, WO

Enclosed is a biological evaluation entitled "A Preliminary Validation of a Douglas-fir Beetle Hazard Rating System, Mountain Home Ranger District, Boise National Forest."

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for LAURA B. FERGUSON
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# A PRELIMINARY VALIDATION OF A DOUGLAS-FIR BEETLE HAZARD RATING SYSTEM MOUNTAIN HOME RANGER DISTRICT, BOISE NATIONAL FOREST 1992

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## ABSTRACT

Stands in the Burnt Creek/Smith Creek Salvage Sale area on the Boise National Forest were hazard rated for Douglas-fir beetle occurrence using 1987 stand exam data. The hazard rating system developed by R.W. Thier performed well in these stands. High hazard stands had a 67 percent probability of infestation by Douglas-fir beetle during a 2-year period which coincided with a forestwide outbreak. Only 16 percent of these high hazard stands had significant mortality (> 1 tree/acre). None of the moderate or low hazard stands sustained significant mortality during the evaluation period.

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## INTRODUCTION

Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk., is one of several native bark beetles which is capable of causing mortality in conifer stands in the west. Douglas-fir beetles kill Douglas-firs, preferring mostly mature to overmature large diameter Douglas-firs growing in mixed or pure stands. Mortality caused by the Douglas-fir beetle is usually not evenly nor randomly distributed throughout the stand. Usually mortality is concentrated in pockets which range in size from a few trees to hundreds of trees.

Hazard rating systems have been developed for some of the native bark beetles including mountain pine beetle, *D. ponderosae* Hopk., and spruce beetle, *D. rufipennis* (Kirby), (Amman et al. 1977, Schmid and Frye, 1976). These hazard rating systems attempt to assign a low, moderate or high risk to stands of timber based upon stand and site characteristics. While a published Douglas-fir beetle hazard rating is not available, many of the underlying stand and site factors associated with beetle activity have been described independently. The relationship between Douglas-fir beetle caused mortality and stand density as a measure of moisture stress and shaded stem environment has been documented (Furniss 1962 & 1979, Rudinsky 1962 & 1966). Species diversity plays a role in stand susceptibility and infested spot growth (Furniss et al. 1981). Evidence indicates that most Douglas-firs which die from Douglas-fir beetle attacks exceed 120 years of age (Furniss et al. 1981 & 1972, Ringold et al. 1965). Predisposing factors such as fire injuries, windthrow, snow breakage, defoliation and root diseases all influence the probability of occurrence and the intensity of an outbreak (Berryman and Wright 1978, Furniss 1962, Furniss et al. 1979, R.L. Furniss 1941, McMullen and Atkins 1962, Vite and Rudinsky 1962).

In 1984 R.W. Thier developed a Douglas-fir beetle hazard rating system which is used by land managers in the Intermountain Region to identify high hazard stands and prioritize treatment. While this system is based upon published relationships between site and stand factors and associated damage caused by Douglas-fir beetle, the hazard rating system has never been field validated. In this paper we describe the results of a preliminary validation.

## METHODS

Hazard ratings were based on the following stand attributes (Thier, unpublished).

Stand Basal Area - the average basal area in square feet per acre of all live trees.

Proportion of the Stand Basal Area in Douglas-fir - the mean basal area in square feet per acre of all live Douglas-firs divided by the mean stand basal area.

Average Stand Age - average stand age in years taken from at least two site trees per plot.

Average Diameter of Douglas-fir Sawtimber - the average diameter at breast height of all Douglas-firs greater than 9 inches in diameter.

The ranges in attribute values were divided into discrete classes and a rating value was assigned to each class.

| *Attribute* | *Range* | *Rating* |
|---|---|---|
| Stand Basal Area ($ft^2$/ac) | <120 | 0.5 |
| | 120 - 250 | 1.0 |
| | >250 | 1.5 |
| Proportion of Stand Basal Area in Douglas-fir (%) | <25 | 1.0 |
| | 25 - 50 | 2.0 |
| | >50 | 3.0 |
| Average Stand Age (years) | <80 | 1.0 |
| | 80 - 120 | 2.0 |
| | >120 | 3.0 |
| Average DBH of Douglas-fir Sawtimber (in) | <10 | 1.0 |
| | 10 - 14 | 2.0 |
| | >14 | 3.0 |

We used available stand exam data for 64 stands in compartments 503, 505, and 511 in the Burnt Creek/Smith Creek Salvage Sale Area of the Mountain Home Ranger District, Boise National Forest, to hazard rate stands for susceptibility and vulnerability to Douglas-fir beetle infestations. Stand exam data were collected in 1987 which coincided with the beginning of an extensive Douglas-fir beetle outbreak on the Boise National Forest.

Each stand was hazard rated by determining the appropriate attribute rating for each of the four attributes and summing these attribute ratings to obtain a stand hazard rating. Low hazard stands had ratings ranging from 0 - 4, moderate hazard stands had ratings ranging from 5 - 7, and high hazard stands had ratings ranging from 8 - 11.

Validation of the hazard rating was attempted using 1988 aerial resource photography (1:15,840) available for the same 64 stands. The imagery was used to identify and compare recent mortality with the predicted hazard ratings. Stand boundaries were hand transferred from stand maps to photos. Then the number of red trees assumed to be recent mortality caused by Douglas-fir beetle and found within each stand boundary were counted under 7X magnification. Red trees visible in the photos probably died within a 2-year period prior to the photographic mission. We did not verify the accuracy of the photointerpretation; however, we feel that these mortality estimates are good relative indicators of Douglas-fir beetle activity in the various stands. Mortality estimates were converted to trees per acre and subjectively partitioned into three classes (0, <1, >1 trees/ac).

A chi-square test of significance was used to test whether the three hazard ratings (low, moderate, high) and the three mortality classes (0, <1, >1 trees/ac) are independent.

## RESULTS

The total hazard rated area covered 2,559 acres. Seventy six percent of this area (1,944 acres) was classified as high hazard and 23 percent (596 acres) was classified as moderate hazard. Only one percent (19 acres) was rated as low hazard.

Forty six stands were rated high hazard. Of the 46 stands rated high hazard, 15 were uninfested as determined via the 1988 aerial photography. Twenty six of these stands lost less than one tree per acre with losses averaging 0.36 trees per acre. Five stands lost more than one tree per acre with losses averaging 1.80 trees per acre (Table 1.).

Based on the above information high hazard stands had a 67 percent probability of losing some trees to Douglas-fir beetle. However, only 16 percent of the high hazard stands with losses, had significant losses or what might be termed epidemic losses. For the purposes of this report, epidemic losses are defined as mortality rates of greater than one tree per acre. This rate was selected because it probably indicates a clustering of mortality indicative of a multiple tree spot or infestation.

Seventeen stands were classified in the moderate risk category. These stands had a 29 percent probability of losing trees and losses averaged 0.34 tree per acre. Mortality rates of less than one tree per acre are indicative of scattered mortality where a few high risk trees are killed but the stand is not generally infested with multi-tree spots. None of the 17 stands had losses exceeding one tree per acre (Table 1).

Only one stand rated a low hazard rating and this stand was uninfested (Table 1).

The null hypothesis was disproved via a significant chi-square test (chi-square = 9.1592 with 4 degrees of freedom, probability level = .0572). Therefore hazard rating classes and mortality classes are not independent.

Table 1. The number of stands cross tabulated by hazard rating and mortality class within the Burnt Creek/Smith Creek Salvage Sale Area.

| | Hazard Rating Classes | | | |
|---|---|---|---|---|
| Mortality Classes | Low | Moderate | High | Totals |
| 0 tree/ac | 1 | 12 | 15 | 28 |
| <1 tree/ac | 0 | 5 | 26 | 31 |
| >1 tree/ac | 0 | 0 | 5 | 5 |
| Totals | 1 | 17 | 46 | 64 |

## DISCUSSION AND CONCLUSIONS

This hazard rating system performed well in the Burnt Creek/Smith Creek Salvage Sale area. The hazard rating system correctly identified the five stands which experienced the greatest losses. It appears that mortality rates of greater than one tree per acre over a one or two year period are probably indicative of epidemic beetle populations, while mortality rates of less than one tree per acre are probably typical under endemic population levels or background levels.

In theory in order to significantly reduce the potential for future Douglas-fir beetle outbreaks, a large proportion of the area must be managed to reduce the susceptibility. Using this hazard rating system, high hazard stands could be identified and the rating could be factored into the decision making process used to prioritize treatments.

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